STUDY REPORT
CAA-SR-99-3

MODELING TO OPTIMIZE RESTORATION TRACKING AND INVESTMENTS (MORTI)

AUGUST 1999

PREPARED BY
RESOURCE ANALYSIS DIVISION

CENTER FOR ARMY ANALYSIS
DEPARTMENT OF THE ARMY
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CENTER FOR ARMY ANALYSIS

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13. ABSTRACT (Maximum 200 words)

The purpose of this study was to develop and analyze alternative strategies for distributing funds to major Army commands for environmental restoration projects. The years of analysis were fiscal years 2001 to 2014. Study was limited to US Army environmental restoration projects currently scheduled for Active Component installations and did not include Formerly Used Defense Sites and restoration sites due to BRAC.

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MODELING TO OPTIMIZE RESTORATION TRACKING AND INVESTMENTS (MORTI)

SUMMARY

THE STUDY PURPOSE was to develop and analyze alternative strategies for distributing funds to major Army commands (MACOMs) for environmental restoration projects.

THE STUDY SPONSOR was the Assistant Chief of Staff for Installation Management (ACSIM).

THE SCOPE OF THIS STUDY was limited to US Army environmental restoration projects currently scheduled for Active Component installations and did not include Formerly Used Defense Sites (FUDS) and restoration sites due to Base Realignment and Closure (BRAC). In addition, the Massachusetts Military Reserve and the Rocky Mountain Arsenal were not considered because of the politically charged nature of the installations. As an example of a restoration project, a contaminated aquifer is an environmental restoration site whose remedy-in-place is a pump-and-treat plant. The years of analysis were fiscal year (FY) 2001 to FY 2014.

THE MAIN ASSUMPTION was that the list of environmental restoration projects provided by the Army Environmental Center (AEC) was complete and that the project costs were correct.

THE BASIC APPROACH was to develop an integer programming model to schedule the environmental restoration projects and alter the objective function (e.g., prioritize by site risk) or constraints (e.g., budget available) to enforce different priorities and programmatics. ACSIM provided four alternatives to be examined. Each alternative was examined using two funding streams. The alternatives were:

(1) Prioritize by site risk. In other words, start high-risk sites as early as possible; followed by medium risk, with low risk sites and those sites, which had not been evaluated, last. In this alternative, costs for long-term monitoring (LTM) and long-term operations (LTO) are incurred every year for 20 years after they start.

(2) Prioritize by site risk as above, but limit the costs for LTM and LTO to 5 years. In other words, the costs for LTM and LTO are shifted from the environmental restoration account to the base operating account after 5 years instead of 20.

(3) Prioritize by MACOM. In this alternative, the Office of the Director of Environmental Programs (ODEP) provided a list of MACOMs that should have all projects completed as soon as possible. In general, these MACOMs had a relatively small number of sites. The MACOMs, in order of priority, are the US Military Academy, the Military District of Washington, the US Army Corps of Engineers, the Medical Command, and then all other MACOMs. As in Alternative 1, the cost for LTM and LTO was incurred for 20 years.

(4) Prioritize by MACOM as above, but limit the costs for LTM and LTO to 5 years as in Alternative 2.

THE PRINCIPAL FINDINGS are

(1) Environmental restoration strategies based on prioritizing having remedy-in-place at high-risk sites as soon as possible reduces the number of high-risk site/phases faster, with a tradeoff in the number of site/phases started early (i.e., fewer projects start early). This is because the high-risk site/phases are generally more expensive than the lower risk sites. When the high-risk site/phases are started earlier, a small number of site/phases consume the budget in the early years.

(2) Environmental restoration strategies based on prioritizing having remedy-in-place at specific MACOMs as soon as possible reduces the number of site/phases faster and completes more installations faster by starting low-cost site/phases earlier, but the tradeoff is that the number of high-risk site/phases do not decrease as fast. Because the priority is on completing all projects within specified MACOMs and, as always, starting all site/phases as soon as possible, the lower-cost, lower-risk site/phases are completed earlier.

(3) MACOM environmental restoration requirements are not within funding constraints. This is because the MACOM requirements are what the MACOMs would like to accomplish and are not constrained by the Program Objective Memorandum.

(4) Shifting the long-term monitoring and long-term operations cost from the environmental restoration account to the base operating account after 5 years instead of 20 reduces the outyear costs for the environmental restoration account, but the early planning year costs do not change significantly. The earliest that the LTM and LTO funds can shift to the base operating account is FY 2006. But, because LTM and LTO are the final phases, they generally start later, so that most of the funds shift further into the planning horizon. Therefore, the total costs of projects in the earlier years are the same for all alternatives.

(5) There is no significant difference in the strategies of the alternatives when projecting the FY 2004 budget for FY 2006-FY 2014 and projecting the FY 2005 budget for those years. The differences in the budgets start in FY 2006. The term "budget" is used to reflect funding programmed throughout the period FY 2001-FY 2014. The budget using the FY 2004 figure in the outyears has slightly more money than the one using FY 2005 budget figure. Therefore, the number of site/phases decreases slightly faster for the FY 2004 budget case after FY 2006. But the largest decreases are in the earlier years, so the differences are minimal.

THE STUDY EFFORT was directed by Ms. Linda Coblentz, Resource Analysis Division, Center for Army Analysis.

COMMENTS AND QUESTIONS may by directed to the Director, Center for Army Analysis, Department of the Army, ATTN: CSCA-RA, 6001 Goethals Road, Suite 102, Fort Belvoir, VA 22060-5230.

CHAPTER 1. INTRODUCTION

1.1 Background

Environmental restoration is defined as "actions taken to identify contaminated sites, assess risk, and clean up hazardous wastes from previous Army activities." The US Army has hundreds of active duty installations that require such actions. The Defense Planning Guidance mandates that all of these installations have a remedy in place by fiscal year (FY) 2014. Remedy in place is defined as having completed all phases of clean-up and having long-term operations (LTO) and/or long-term monitoring (LTM) in place. In addition, it requires sites with the most serious environmental hazards, defined as high-risk sites, to have remedy-in-place by FY 2007. As an example, a contaminated aquifer in a populated area is a high-risk site whose remedy-in-place (or long-term operation) is a pump-and-treat plant that will continue to clean the water beyond the planning horizon.

The cost to clean up these installations is in the billions of dollars. The Office of the Assistant Chief of Staff for Installation Management (ACSIM) provides restoration funds to the major Army commands (MACOMs). The MACOMs then provide funding to the installations. Currently, the distribution of the funds from the ACSIM to the MACOMs is determined by a rule-of-thumb procedure, based on preliminary examination of the relative risk of the restoration sites within a MACOM and the Army goals.

1.2 Purpose

Although the procedure mentioned above is generally adequate, ACSIM required a more analytical approach to support its development of the Program Objective Memorandum (POM). In addition, they desired the ability to perform "what-if" analyses with respect to changing priorities and programmatics. As an example of changing priorities, ACSIM was interested in the effects on project completion when the priority was changed from completing high-risk sites as soon as possible to completing all the sites at certain MACOMs as soon as possible. As an example of changing programmatics, the Army Environmental Center (AEC) was interested in finding out what would happen if the length of long-term monitoring and long-term operations were cut from 20 years to 5 years. ACSIM requested that the Center for Army Analysis (CAA) develop an analytical approach to enable them to achieve their goals.

1.3 Approach

This analysis developed a large-scale integer programming model to meet ACSIM's requirements. The model consists of an objective function and a base set of constraints which includes being within budget and maintaining the order and length of the clean-up phases. To perform the "what-if" analyses on changing priorities, the coefficients of the objective function were changed to reflect the new priorities. To perform the analyses on changing programmatics, the constraints were altered. The general formulation is discussed in detail in Chapter 2.

1.4 Scope and Assumptions

The analysis was limited to US Army restoration projects currently scheduled for active installations and did not include Formerly Used Defense Sites (FUDS) and restoration due to Base Realignment and Closure (BRAC). In addition, the Massachusetts Military Reserve and

the Rocky Mountain Arsenal were not considered because of the politically charged nature of the installations. The data for this analysis were provided by AEC. There are over 3,300 site/phase combinations. The two major assumptions required for this analysis are 1) that the list of site/phase combinations is complete and 2) that the costs are accurate.

CHAPTER 2. MODEL FORMULATION

2.1 General Description

This analysis used an integer programming model. The purpose of the program is to determine the year in which a particular phase of an environmental restoration is started. Each restoration site can have up to seven phases, and these phases must be completed in a particular order (Figure 1). Long-term maintenance and long-term operations are the final phases and can occur at the same time. Sites do not have to have every phase. In addition, for this analysis, each phase has a length of 1 year. It is assumed that each phase is paid for in the year in which it is started. The exceptions to this general rule are long-term monitoring and long-term operations. These phases incur a cost the year they are started and every year after that for 20 years. (Note: the length of time for which LTM and LTO are paid for out of restoration funds is one of the programmatics that can be changed in follow-on "what-if" analysis.)

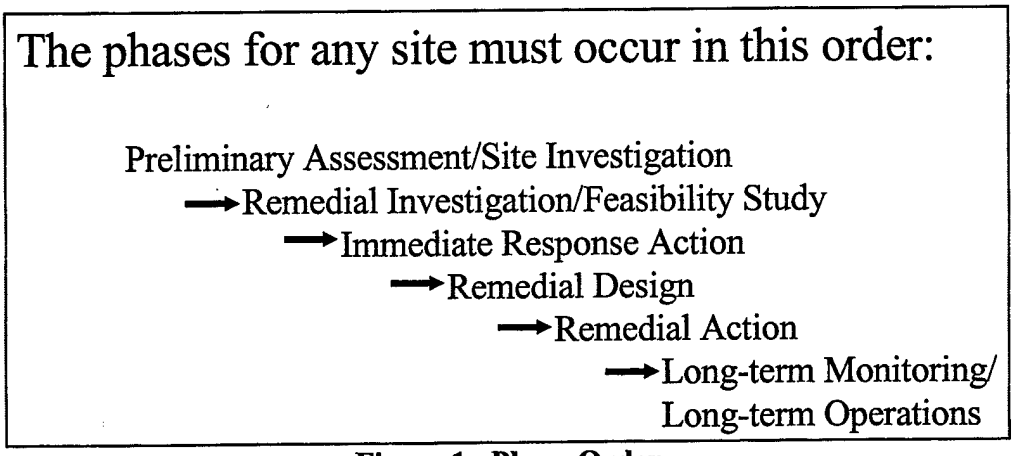

Figure 1. Phase Order

2.2 Mathematical Formulation

This paragraph describes in detail the mathematical formulation for the model. In the notation, i refers to a site, j and n to phases, and k to a year.

a. The variables in the model are:

x_{ijk} = 1 if site i, phase j is started in year k, 0 otherwise.

b. The data elements for the model are:

b_k = budget for year k,

c_{ij} = cost of site i, phase j,

a_{ijk} = objective coefficient for site i, phase j, in year k,

SP = the set of site/phase combinations under consideration,

$Years$ = the years under consideration (FY 2001 - FY 2014)

All of the data are provided by the sponsor with the exception of the a_{ijk}. The objective function coefficients are the means by which the priorities are enforced. The higher priority sites have a higher objective function value, or weight. As such, these data elements are left to the discretion of the modeler. In addition to the weights to enforce priorities, the coefficients are constructed in such a way that starting early in the planning horizon is weighted higher than starting late.

c. The constraints are described below.

(1) Every site/phase combination must be started once and only once.

$$\sum_{k \in Years} x_{ijk} = 1, \forall (i,j) \in SP$$

(2) The budget cannot be exceeded in any year. The costs incurred in a year include the cost of any site/phase combination that starts in that year, and the yearly cost of LTM/LTO, if those phases have begun previous to that year.

$$\sum_{\substack{(i,j) \in SP \\ j \notin \{LTM, LTO\}}} c_{ij} x_{ijk} + \sum_{\substack{(i,j) \in SP \\ j \in \{LTM, LTO\}}} \sum_{y=2001}^{k} c_{ij} x_{ijy} \le b_k, \forall k \in Years$$

(3) The following constraint imposes the phase ordering. In the notation below, phase n precedes phase j.

$$\sum_{y=2001}^{k-1} x_{iny} \ge x_{ijk}, \quad \forall k; \forall \{i,j,n \mid (i,j),(i,n) \in SP; j > n\}$$

These constraints provide inherent special ordered sets. A variable for a phase cannot be set to 1 unless a variable for all of the preceding phases has been set to 1 in a previous year. This feature provides a powerful branching feature in solving the model which can speed up the solution time.

d. The objective function is

$$Maximize \sum_{(i,j) \in SP} \sum_{k \in Years} a_{ijk} x_{ijk}$$

where a_{ijk} is the objective function coefficient. These coefficients are changed to enforce the different priorities in the "what-if" analyses.

e. This problem is extremely large. There are over 3,300 site/phase combinations that must be scheduled over 14 years. Consequently, there are almost 170,000 binary variables. In the general case, the probability of getting a solution to a model of this size is very small. However, because the objective function coefficients are left to the discretion of the modeler, the objective function can be structured in such a way so as to provide more powerful branching and pruning. Additionally, there are some inherent special ordered sets within the structure of the model that improves the probability of getting a solution.

CHAPTER 3. ANALYSIS OF ALTERNATIVE STRATEGIES

3.1 General Information

ACSIM provided four alternatives to be examined. Each alternative was examined using two budget streams. One budget stream used the FY 2005 budget as the budget for FY 2006 through FY 2014. The other used the FY 2004 budget for FY 2006 through FY 2014. The term "budget" is used to reflect funding programmed throughout the period FY 2001-FY 2014.

3.2 The Alternatives

Four alternatives were examined. These were:

a. Prioritize by site risk. In other words, start high-risk sites as early as possible, followed by medium risk, with low risk sites and those sites which had not been evaluated last. The risk factor for a site was provided by the sponsor. In this alternative, costs for long-term monitoring and long-term operations are incurred in the environmental restoration account every year for 20 years after they start. After 20 years, the costs of LTM and LTO are shifted to the base operating accounts.

b. Prioritize by site risk as above, but limit the costs for LTM and LTO to 5 years. In other words, the costs for LTM and LTO are shifted from the environmental restoration account to the base operating account after 5 years instead of 20.

c. Prioritize by MACOM. In this alternative, the Office of the Director of Environmental Programs (ODEP) provided a list of MACOMs that should have all projects completed as soon as possible. In general, these MACOMs had a relatively small number of sites. The MACOMs, in order of priority, are the US Military Academy, the Military District of Washington, the US Army Corps of Engineers, the Medical Command, and then all other MACOMs. As in Alternative A, the cost for LTM and LTO was incurred for 20 years.

d. Prioritize by MACOM as above, but limit the costs for LTM and LTO to 5 years as in Alternative B.

3.3 Results

The following charts provide summarized results of the analysis. More detailed results are in Appendix C. In all of the charts, MACOM requirements refers to the requirements as identified by the MACOMs, not the current Program Objective Memorandum (POM). These requirements are specified for the years FY 2001-FY 2007. All other requirements are scheduled for FY 2008 and beyond.

Figure 2 shows the annual cost for each alternative over the planning years for the schedule where the FY 2004 budget figure is projected for FY 2006-FY 2014. The budget line from FY 2001 to FY 2014 is based on the 00-05 POM. As can be seen, in the early years of analysis, the

budget constraint is critical. The model solution for each alternative uses all of the funds available in those years. The costs of the solutions for Alternatives A and C are significantly higher than the costs of the solutions for Alternatives B and D from FY 2011 to FY 2014. This is to be expected because Alternatives B and D limit the cost of LTM and LTO to 5 years and therefore require less money in the outyears.

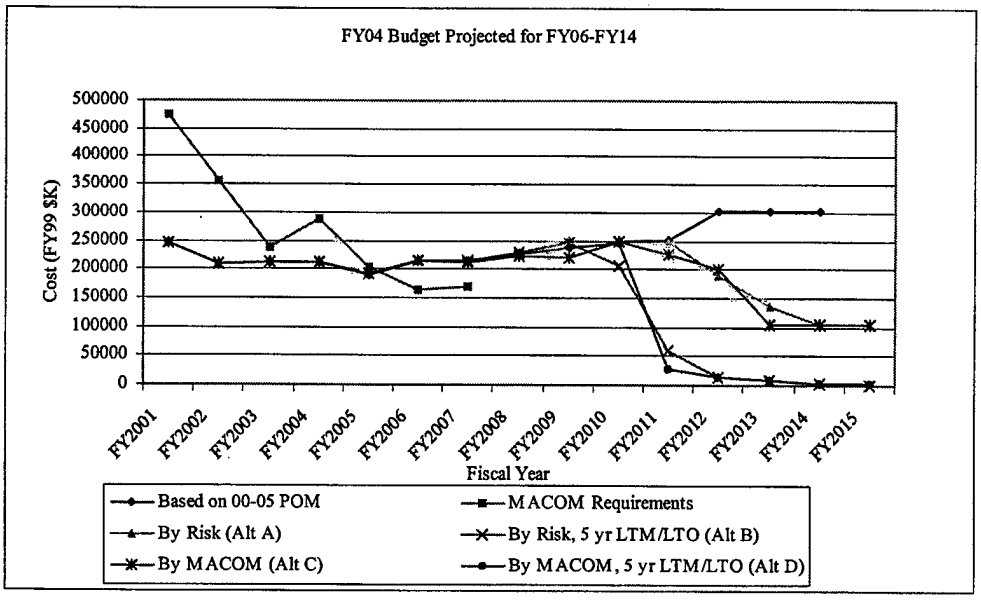

Figure 2. Annual Cost, FY 2004 Budget Projection

Figure 3 shows the annual cost for each alternative over the planning years for the schedule where the FY 2005 budget figure is extended to FY 2006-FY 2014. As in Figure 2, the budget constraint is critical and there are significant differences between the cost of the solutions for Alternatives A and C and the cost of the solutions for Alternatives B and D in the outyears.

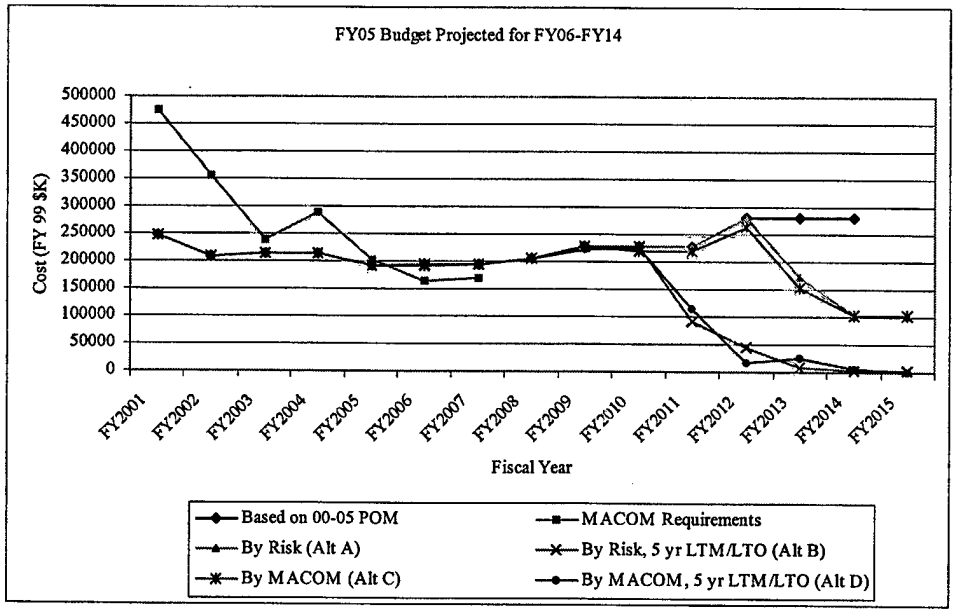

Figure 3. Annual Cost, FY 2005 Budget Projection

Figure 4 depicts the number of site/phase combinations yet to be started for the schedule where the FY 2004 budget figure is extended to FY 2006-FY 2014. As can be seen, the alternatives that prioritize by risk (Alternatives A and B) do not decrease as quickly as those that prioritize by MACOM (Alternatives C and D) do. The alternatives that limit LTM and LTO costs to 5 years (Alternatives B and D) decrease slightly faster than their equivalent alternatives for 20 year LTM and LTO costs (Alternatives A and C, respectively).

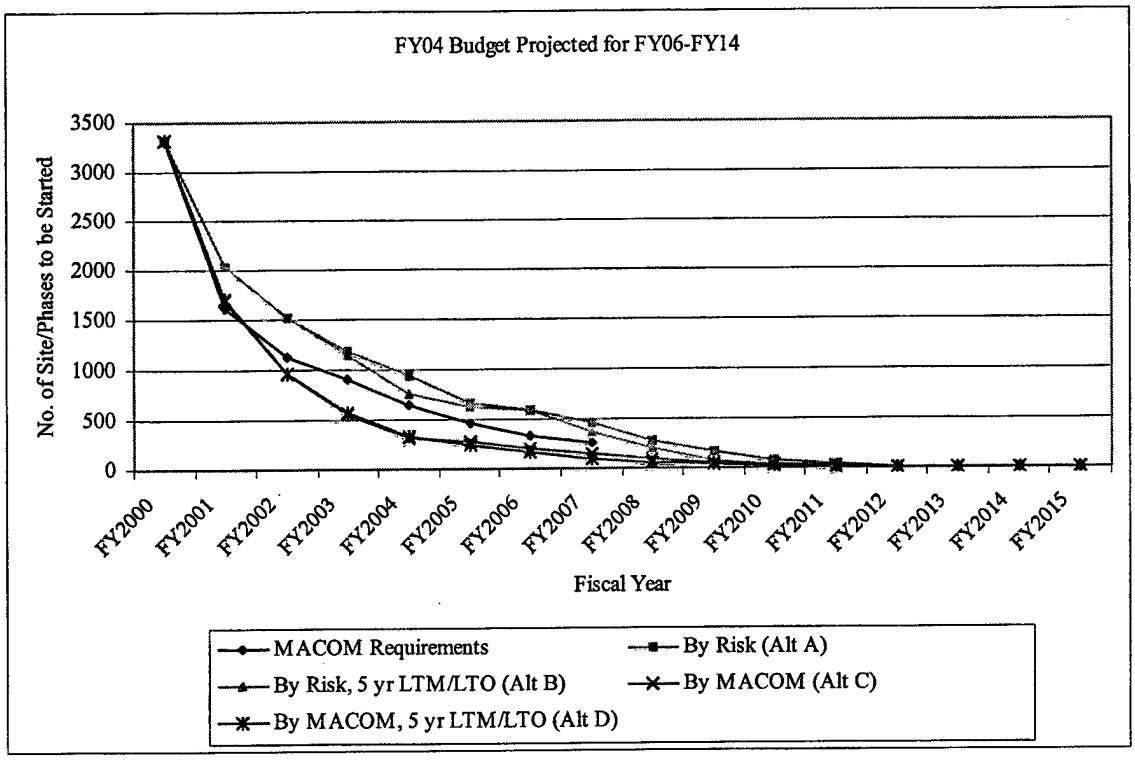

Figure 4. Site/Phase Combinations Remaining, FY 2004 Budget Projection

Figure 5 depicts the number of site/phase combinations yet to be started for the schedule where the FY 2005 budget figure is extended to FY 2006-FY 2014. Similar relationships among the lines exist as in Figure 4.

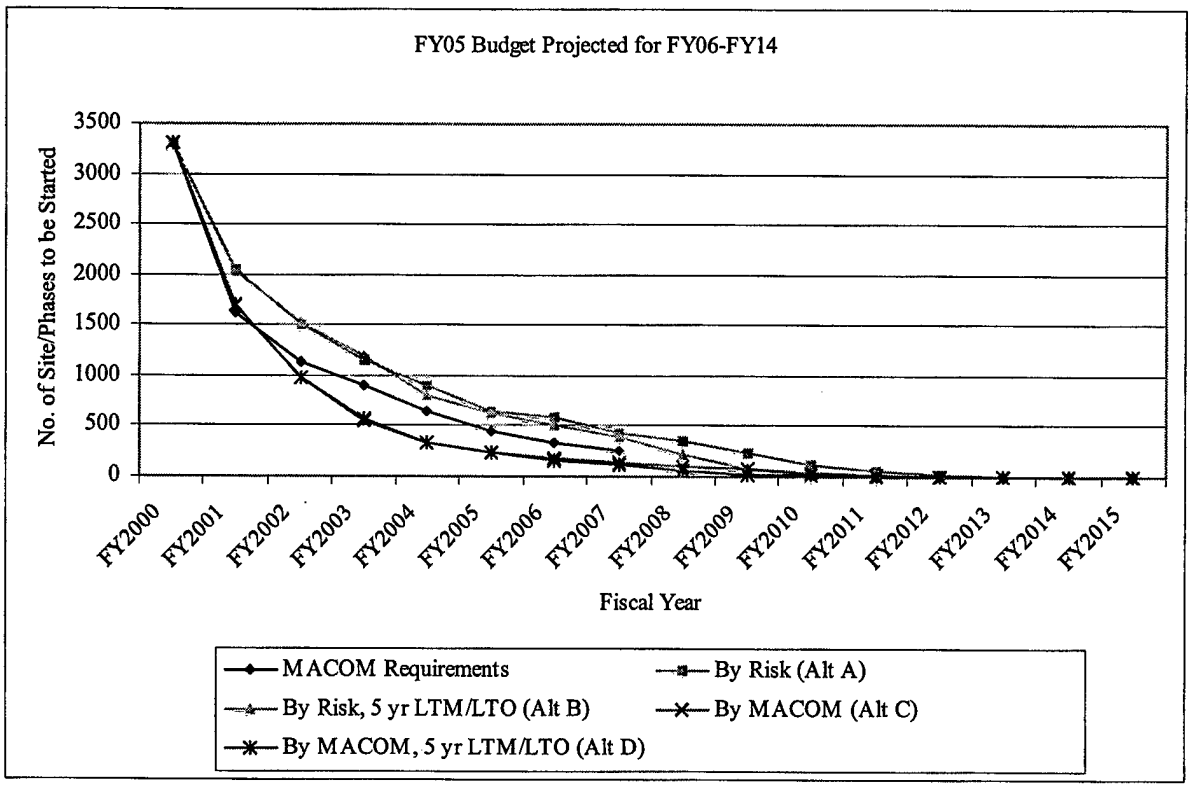

Figure 5. Site/Phase Combinations Remaining, FY 2005 Budget Projection

3.4 Observations

Based on the analysis of the four alternatives, the following observations can be made:

a. Alternatives A and B reduce the number of high-risk site/phases faster, with a trade-off in the number of site/phases started early (i.e., fewer projects start early). This is because the high-risk site/phases are generally more expensive than the lower risk sites. When the high-risk site/phases are started earlier, a small number of site/phases consume the budget in the early years.

b. Alternatives C and D reduce the number of site/phases faster and complete more installations faster by starting low-cost site/phases earlier, but the trade-off is that the number of high-risk site/phases do not decrease as fast. Because the priority is on completing MACOMs and, as always, starting all site/phases as soon as possible, the lower-cost, lower-risk site/phases are completed earlier (see Appendix C, paragraph C-3, Prioritization based on MACOM with LTM/LTO costs incurred for 20 years).

c. MACOM environmental restoration requirements are not within funding constraints. Recall that the MACOM requirements are what the MACOMs would like to accomplish and are not constrained by the POM.

d. Alternatives B and D reduce the outyear costs for the environmental restoration account, but the early planning year costs do not change significantly. The earliest that the LTM and LTO

funds can shift to the base operating account is FY 2006. But, because LTM and LTO are the final phases, they generally start later, so that most of the funds shift further into the planning horizon. Therefore, the total costs of projects in the earlier years are the same for all alternatives.

e. There is no significant difference in the solutions between the two budget streams. The differences in the budgets start in FY 2006. The budget using the FY 2004 figure in the outyears has slightly more money than the one using FY 2005 budget figure. Therefore, the number of site/phases decreases slightly faster for the FY 2004 budget case after FY 2006. But the largest decreases are in the earlier years, so the differences are minimal.

CHAPTER 4. POTENTIAL REFINEMENTS OF THE MODEL

4.1 Introduction

At the end of this study, the sponsor identified areas in which a model could be tailored for use in the current POM build. This chapter discusses the refinements that will be used in follow-on analyses.

4.2 General Refinements

There were two refinements that were identified. These were:

a. Altering the phase lengths. The analysis in this report considered the length of all phases to be the same length--1 year. In follow-on work, the phase lengths can be altered for each type of phase or, if necessary, altered for a phase at a particular site.

b. Smoothing the budget distributions from one year to the next. Funding distributions should not vary greatly from year to year.

4.3 Formulation Refinements

To implement the above refinements, the model formulation will change. The following are the formulation changes.

a. Additional data required for both of the refinements are:

l_{ij} = length of phase j at site i,

$BIGMACOM$ = the set of MACOMs that can be smoothed,

p_{low} = lower bound on the percentage change in cost from the previous year, and

p_{up} = upper bound on the percentage change in cost from the previous year.

b. In order to implement the phase length refinement, the following constraint replaces the phase-ordering constraint in the original formulation.

$$\sum_{y=2001}^{k-l_{in}} x_{iny} \geq x_{ijk}, \quad \forall k; \forall \{i,j,n \mid (i,j),(i,n) \in SP; j > n\}$$

c. The budget smoothing refinements requires two additional sets of constraints. Ideally, all MACOMs would have smooth budget streams. However, due to the phase lengths and the small number of site/phase combinations of some MACOMs, these constraints introduce infeasibility when applied to all but the larger MACOMs. These MACOMs comprise the set *BIGMACOM*.

The following two equations describe the lower and upper bound smoothing constraints. Note that the costs for LTM and LTO are continued to the end of the time frame after these phases are started.

$$\sum_{\substack{(i,j)\in SP \\ j\notin\{LTM,LTO\}}} c_{ij}x_{ijk} + \sum_{\substack{(i,j)\in SP \\ j\in\{LTM,LTO\}}} \sum_{y=2001}^{k} c_{ij}x_{ijy}$$

$$- p_{low}\left(\sum_{\substack{(i,j)\in SP \\ i \text{ in } m \\ j\notin\{LTM,LTO\}}} c_{ij}x_{ijk-1} + \sum_{\substack{(i,j)\in SP \\ i \text{ in } m \\ j\in\{LTM,LTO\}}} \sum_{y=2001}^{k-1} c_{ij}x_{ijy} \right) \geq 0, \forall m \in BIGMACOM, k \in Years$$

and

$$\sum_{\substack{(i,j)\in SP \\ j\notin\{LTM,LTO\}}} c_{ij}x_{ijk} + \sum_{\substack{(i,j)\in SP \\ j\in\{LTM,LTO\}}} \sum_{y=2001}^{k} c_{ij}x_{ijy}$$

$$- p_{up}\left(\sum_{\substack{(i,j)\in SP \\ i \text{ in } m \\ j\notin\{LTM,LTO\}}} c_{ij}x_{ijk-1} + \sum_{\substack{(i,j)\in SP \\ i \text{ in } m \\ j\in\{LTM,LTO\}}} \sum_{y=2001}^{k-1} c_{ij}x_{ijy} \right) \leq 0, \forall m \in BIGMACOM, k \in Years$$

4.4 Remarks

The refinements mentioned above are currently being implemented. The results will support the FY 2002-2007 POM build.

APPENDIX A

STUDY CONTRIBUTORS

STUDY DIRECTOR

Ms. Linda Coblentz, Resource Analysis Division

APPENDIX B

REQUEST FOR ANALYTICAL SUPPORT

REQUEST FOR ANALYTICAL SUPPORT

PART 1

1. Performing Directorate/ Division: RA			2. Account Number:
3. Type Effort (Enter one): Q Mode (Contract=C):	S - Study Q - QRA P - Project R - RAA M - MMS	4. Tasking (Enter one): V	F - Formal Directive I - Informal V - Verbal
5. Title: Modelling to Optimize Restoration Technology and Investments			
6. Acronym: MORTI	7. Date Request Received: 06/10/98		8. Date Due: 10/10/98
9. Requester/Sponsor (i.e., DCSOPS): DAIM			10. Sponsor Division (i.e., SSW, N/A) ED
11. Impact on Other Studies, QRA, Projects, RAA: None			
12. Product Required: Optimization model, Memorandum report			
13. Estimated Resources Required:	a. Estimated PSM: 3.0		b. Estimated Funds: $0
c. Models Req'd: none			d. Other:

14. Objective(s)/Abstract:
The ACSIM has requested CAA to help prioritize the allocation of funds for environmental restoration. To do this, CAA will develop and apply an optimization model.

15. Study Director/POC:	Last Name: Coblentz	First: Linda	Date: 06/19/98
	Signature: Linda Coblentz		Phone#: 295-6974

GO TO BLOCK 20 *If this is A STUDY*. See Tab C of the Study Directors' Guide for preparation of a Formal Study Directive.

PART 2

16. Background/Statement of Problem*: ACSIM determines the amount of money given to MACOMs for environmental restoration projects, with input from the Army Environmental Center. High risk sites should be closed as soon as possible, given the annual budgets. ACSIM has requested that CAA help AEC with this process.

17. Scope of Work*: This project is limited to currently planned restoration projects in the United States that are scheduled to begin before FY2014. The data used will be the data spreadsheet provided by AEC.

18. Issues for Analysis*: What are alternatives to distribute money to the MACOMs for environmental restoration?

19. Milestones/Plan of Action*:
17 July 1998: Draft model ready for review
31 July 1998: Proof of Concept model complete.
11 Sep 1998: Brief sponsor.

20. Division Chief Concurrence:	Steve Sargent	Date: 9/3/98
21. Sponsor (COL/DA Div Chief) Concurrence:	James C. Dyke	Date: 11 Sep 98

22. Sponsor Comments*:

CAA Form 233 (1 May 95) * Continue on separate sheet Previous editions Obsolete

APPENDIX C

RESULTS

The following tables provide the results of the analysis. For each of the alternatives, there are five tables for each budget stream.

The first table gives the annual cost of the projects as scheduled by the model broken out by risk factor. The risk factors, in order of severity, are High, Medium, Low, and Not Evaluated (i.e., a risk factor has not been assigned to that site). The risk factor for a site is provided by the sponsor. The cost figure in the FY 2015 column is the cost of LTM and LTO that will continue for several years beyond the planning horizon. The second table gives the annual cost broken out by MACOM.

The third table gives the number of site/phase combinations that are remaining, broken out by risk factor. As can be seen by the tables, all site/phase combinations are funded by FY 2014 for all alternatives. The fourth table provides this information broken out by MACOM.

The fifth table gives the number of installations that have achieved remedy in place for all sites in that particular year. Note that these numbers are not cumulative. Remedy-in-place is defined as having completed all phases of cleanup and to have long-term operations and monitoring in place.

C.1 ALTERNATIVE A. Prioritization based on risk with LTM/LTO costs incurred for 20 years.

For the budget in which the FY 2004 figure is projected for FY 2006 - FY 2014.

Costs by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	227456	201495	201437	201990	117234	208510	162776	123947	163259	81914	81885	81885	81885	81885	81885
Medium	18215	7044	11040	9584	61043	6230	46592	71654	69640	77485	126420	61092	13636	13636	13636
Low	764	112	302	1254	12764	1088	6449	31763	15374	87893	36688	25749	40311	7845	7845
Not Eval	0	0	0	0	0	0	11	664	755	1736	4832	20679	567	567	567
Total	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	249825	189405	136399	103933	103933
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	176970	143622	146490	171788	125234	122751	148283	172565	212445	163498	195825	139503	69497	68959	68959
USACE	158	98	98	98	98	98	3120	354	354	354	354	354	354	354	354
FORC	18380	17942	24877	12357	21826	70122	20196	18693	16686	17813	15434	15434	15434	15434	15434
MDW	850	451	451	461	461	461	533	533	533	533	533	533	533	533	533
MEDCOM	146	146	146	2573	801	146	23771	760	760	2920	771	771	771	771	771
NGB	5847	15801	9215	10851	4070	2267	2550	4243	2895	10578	3258	2410	2410	2410	2410
TRADOC	17104	14125	22467	5810	18297	4317	5117	13580	5527	24556	13736	8855	5295	5295	5295
USAPC	15382	4441	3198	3255	6820	3343	5849	7158	3722	17577	13521	15152	35712	3784	3784
USARC	10895	11732	5544	5342	13141	12030	6116	9849	5813	10906	6100	6100	6100	6100	6100
USMA	703	293	293	293	293	293	293	293	293	293	293	293	293	293	293
Total	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	249825	189405	136399	103933	103933
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	918	417	254	137	41	10	17	7	4	4	0	0	0	0	0
Medium	282	102	59	37	84	32	25	38	19	8	5	3	0	0	0
Low	72	6	18	70	153	24	91	109	71	71	30	8	3	1	0
Not Eval	0	0	0	0	0	0	2	22	16	14	11	8	5	0	0
Total	1272	525	331	244	278	66	135	176	110	97	46	19	8	1	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	799	364	249	174	157	33	60	99	71	51	23	10	5	1	0
USACE	6	0	0	0	0	0	1	2	0	0	0	0	0	0	0
FORC	125	41	17	18	13	8	14	10	5	7	0	0	0	0	0
MDW	9	2	0	1	0	0	2	0	0	0	0	0	0	0	0
MEDCOM	2	0	0	1	1	0	2	2	0	1	1	0	0	0	0
NGB	22	13	6	5	11	1	5	5	6	6	3	0	0	0	0
TRADOC	148	63	45	30	47	10	22	16	15	23	8	5	1	0	0
USAPC	69	12	1	5	11	3	9	6	4	5	6	4	2	0	0
USARC	72	27	13	10	38	11	20	36	9	4	5	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1272	525	331	244	278	66	135	176	110	97	46	19	8	1	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	0	1	3	3	0	5	3	4	7	7	3	1	1	0
USACE	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
FORC	2	0	3	2	0	0	2	3	0	2	0	0	0	0	0
MDW	3	1	0	1	0	0	1	0	0	0	0	0	0	0	0
MEDCOM	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0
NGB	2	1	0	0	1	0	1	0	1	1	1	0	0	0	0
TRADOC	1	0	1	0	2	2	1	1	2	2	0	2	1	0	0
USAPC	1	2	0	1	1	0	1	1	2	0	0	1	1	0	0
USARC	6	3	5	5	2	3	4	18	4	1	5	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	22	8	10	12	10	5	16	28	13	13	14	6	3	1	0

For the budget in which the FY 2005 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	227122	198288	202799	189493	139205	178513	127643	175054	121136	125570	81891	81926	81885	81885	81885
Medium	18705	10034	9420	21862	41412	13763	50679	25861	74932	64916	62675	172901	14242	13636	13636
Low	608	329	560	1473	10424	1765	15714	5240	29862	35392	81856	20040	56212	7845	7845
Not Eval	0	0	0	0	0	0	5	86	1311	1363	1819	4374	19779	567	567
Total	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	172118	103933	103933
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	174951	158588	150924	147781	139223	111348	129387	145626	179083	178710	145180	231359	96930	68959	68959
USACE	158	98	98	98	98	98	3120	354	354	354	354	354	354	354	354
FORC	20265	16052	15488	22156	20323	41611	18568	41699	20010	16911	16899	15434	15434	15434	15434
MDW	850	451	451	461	481	481	533	533	533	533	533	533	533	533	533
MEDCOM	146	146	146	2573	824	23771	760	760	760	760	2920	771	771	771	771
NGB	5840	3287	15301	15354	3530	2654	3455	2399	3986	3135	9821	3258	2410	2410	2410
TRADOC	16707	13525	19918	13618	10455	5568	12680	5277	8654	12582	18397	13182	7955	5295	5295
USAPC	15382	4441	4148	3322	5734	3419	8398	3714	6520	5549	25294	7982	41338	3784	3784
USARC	11433	11770	6012	7172	10081	4798	16847	5586	7048	8414	8550	6075	6100	6100	6100
USMA	703	293	293	293	293	293	293	293	293	293	293	293	293	293	293
Total	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	172118	103933	103933
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	919	414	250	142	40	15	12	10	6	1	0	0	0	0	0
Medium	281	118	54	52	68	23	28	17	25	17	4	4	3	0	0
Low	55	22	40	60	138	33	111	51	64	78	42	21	10	2	0
Not Eval	0	0	0	0	0	0	1	8	21	19	2	15	7	5	0
Total	1255	554	344	254	246	71	152	86	116	115	48	40	20	7	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	788	393	263	168	134	39	65	39	76	69	22	22	13	5	0
USACE	6	0	0	0	0	0	1	2	0	0	0	0	0	0	0
FORC	125	41	16	18	14	4	14	4	8	9	3	2	0	0	0
MDW	9	2	0	1	1	0	1	0	0	0	0	0	0	0	0
MEDCOM	2	0	0	1	2	1	2	0	0	0	1	1	0	0	0
NGB	21	12	2	9	10	2	10	2	4	4	5	2	0	0	0
TRADOC	147	61	44	35	43	15	20	12	15	21	8	8	3	1	0
USAPC	69	12	2	7	9	3	10	3	4	6	6	3	2	1	0
USARC	68	30	17	15	33	7	29	24	9	6	3	2	2	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1255	554	344	254	246	71	152	86	116	115	48	40	20	7	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	0	1	3	3	2	4	1	3	7	6	3	3	2	0
USACE	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
FORC	2	0	3	1	1	0	2	1	2	1	0	1	0	0	0
MDW	3	1	0	1	0	0	1	0	0	0	0	0	0	0	0
MEDCOM	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0
NGB	1	2	0	0	0	0	2	1	0	0	1	1	0	0	0
TDOC	1	0	1	0	2	0	1	3	1	1	1	2	1	1	0
USAPC	1	2	0	3	0	0	1	0	0	2	1	0	0	1	0
USARC	5	4	5	5	6	1	6	11	6	1	2	2	2	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	20	10	10	13	14	3	18	18	12	12	11	10	6	4	0

C.2 ALTERNATIVE B. Prioritization based on risk with LTM/LTO costs incurred for 5 years.

For the budget in which the FY 2004 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	229605	198542	202417	158266	175623	211533	95028	139445	16138	6125	5424	4257	3638	0	0
Medium	16303	9925	9542	45474	11316	2963	95139	64636	100924	167938	7781	5666	1450	1194	743
Low	527	184	820	9088	4102	1332	25251	22816	123205	12305	46077	3800	2109	1139	92
Not Eval	0	0	0	0	0	0	410	1131	6876	19804	567	481	232	157	88
Total	246435	208651	212779	212828	191041	215828	215828	228028	247143	206172	59849	14204	7429	2490	923
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	177322	143715	154512	141912	153694	162123	145674	178218	167293	190101	12837	8625	4543	1948	849
USACE	158	98	98	98	98	0	3022	256	256	256	256	256	0	0	0
FORC	18380	10052	26034	20768	16809	37132	15073	36668	7867	3854	3854	2987	2207	62	0
MDW	901	451	461	461	461	60	82	72	72	72	72	0	0	0	0
MEDCOM	146	146	2573	801	146	23	23625	614	2774	625	602	602	11	11	0
NGB	5847	22727	1923	12683	2498	1951	2724	2128	9501	150	140	68	53	32	0
TRADOC	16726	15427	17525	19170	5921	2900	12690	4588	29412	4015	1690	863	188	188	41
USAPC	15382	4435	3238	4970	3380	1837	7120	2178	22996	5453	38770	152	68	62	33
USARC	10870	11307	6122	11672	7741	9772	5818	3306	6972	1646	1628	651	359	187	0
USMA	703	293	293	293	293	30	0	0	0	0	0	0	0	0	0
Total	246435	208651	212779	212828	191041	215828	215828	228028	247143	206172	59849	14204	7429	2490	923
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	920	414	255	135	35	23	15	8	4	0	0	0	0	0	0
Medium	283	110	48	91	43	1	48	45	16	7	2	0	0	0	0
Low	61	6	60	163	63	9	141	91	89	35	6	3	0	0	0
Not Eval	0	0	0	0	0	0	16	27	20	10	5	0	0	0	0
Total	1264	530	363	389	141	33	220	171	129	52	13	3	0	0	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	794	373	263	249	71	26	112	104	68	28	7	1	0	0	0
USACE	6	0	0	0	0	0	1	2	0	0	0	0	0	0	0
FORC	125	39	22	20	11	1	18	11	9	2	0	0	0	0	0
MDW	10	1	1	0	0	0	2	0	0	0	0	0	0	0	0
MEDCOM	2	0	1	1	0	1	1	2	1	1	0	0	0	0	0
NGB	22	14	6	9	7	1	8	6	9	1	0	0	0	0	0
TRADOC	148	63	45	64	26	2	22	23	25	11	3	1	0	0	0
USAPC	69	11	6	9	2	0	14	8	8	6	3	1	0	0	0
USARC	68	26	19	37	24	2	42	15	9	3	0	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1264	530	363	389	141	33	220	171	129	52	13	3	0	0	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	0	3	4	0	1	7	2	6	12	2	1	0	0	0
USACE	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
FORC	2	0	2	2	1	0	2	2	2	1	0	0	0	0	0
MDW	3	1	1	0	0	0	1	0	0	0	0	0	0	0	0
MEDCOM	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0
NGB	2	1	0	0	0	0	1	1	2	1	0	0	0	0	0
TDOC	1	0	1	1	2	0	2	3	0	3	1	1	0	0	0
USAPC	1	2	1	1	1	0	1	1	1	0	1	1	0	0	0
USARC	7	3	7	6	3	0	15	7	5	3	0	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	23	8	15	15	7	2	29	18	16	21	4	3	0	0	0

For the budget in which the FY 2005 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	226667	202202	203837	174555	147135	179881	115549	111162	59076	12826	5573	3940	3638	0	0
Medium	19296	6370	8464	31946	36092	10043	59465	60487	75478	167471	56210	5171	1634	1277	1167
Low	472	79	478	6327	7814	4112	18884	33314	89353	37660	15198	35580	2352	1047	187
Not Eval	0	0	0	0	0	5	143	1278	3334	9087	14940	481	157	157	103
Total	246435	208651	212779	212828	191041	194041	194041	206241	227241	227044	91921	45172	7781	2481	1457
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	170911	147356	143781	155014	139156	121643	161430	147873	171014	192577	75766	8543	4543	1951	1324
USACE	158	98	98	98	98	0	0	3022	256	256	256	256	256	0	0
FORC	20270	16052	24906	13353	20200	37428	13325	36456	6953	3964	3564	2957	2257	62	0
MDW	901	451	451	481	481	132	82	82	52	52	0	0	0	0	0
MEDCOM	2573	146	146	169	918	23531	614	614	2751	602	602	11	11	11	0
NGB	5847	15801	8825	12439	3164	2128	1935	2385	6842	2780	75	75	65	32	32
TRADOC	18895	13081	17561	17318	10528	3616	8137	6024	20716	13541	725	621	335	188	68
USAPC	15382	4441	3216	4367	5625	1980	2869	5721	12582	11625	10022	32068	82	62	33
USARC	10795	10932	13502	9296	10578	3554	5649	4064	6075	1647	911	641	232	175	0
USMA	703	293	293	293	293	30	0	0	0	0	0	0	0	0	0
Total	246435	208651	212779	212828	191041	194041	194041	206241	227241	227044	91921	45172	7781	2481	1457
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	920	413	255	134	35	19	16	10	6	1	0	0	0	0	0
Medium	287	106	41	80	65	19	30	36	17	8	3	2	0	0	0
Low	58	4	38	162	91	64	76	99	92	31	9	3	0	0	0
Not Evaluated	0	0	0	0	0	1	9	28	18	12	7	3	0	0	0
Total	1265	523	334	376	191	103	131	173	133	52	19	8	0	0	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	794	369	253	239	93	43	83	111	67	27	11	6	0	0	0
USACE	6	0	0	0	0	0	0	1	2	0	0	0	0	0	0
FORC	126	40	17	21	12	9	11	9	11	2	0	0	0	0	0
MDW	10	1	0	2	0	1	0	0	0	0	0	0	0	0	0
MEDCOM	3	0	0	1	1	1	2	0	1	1	0	0	0	0	0
NGB	22	13	5	8	11	4	2	7	8	2	1	0	0	0	0
TRADOC	148	60	42	59	31	17	12	19	28	12	5	0	0	0	0
USAPC	69	12	3	10	7	3	5	8	10	6	2	2	0	0	0
USARC	67	25	14	36	36	25	16	18	6	2	0	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1265	523	334	376	191	103	131	173	133	52	19	8	0	0	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	1	1	5	2	0	8	1	7	9	1	3	0	0	0
USACE	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
FORC	2	0	3	2	0	0	2	2	2	1	0	0	0	0	0
MDW	3	1	0	1	0	1	0	0	0	0	0	0	0	0	0
MEDCOM	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0
NGB	2	1	0	0	1	1	0	0	2	0	1	0	0	0	0
TDOC	1	0	0	2	2	1	1	2	1	2	3	0	0	0	0
USAPC	1	2	0	2	1	0	0	1	2	1	0	1	0	0	0
USARC	6	3	5	8	3	8	8	9	4	2	0	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	22	9	9	21	10	11	20	15	19	16	5	4	0	0	0

C.3 ALTERNATIVE C. Prioritization based on MACOM with LTM/LTO costs incurred for 20 years.

For the budget in which the FY 2004 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	152199	119829	126551	156691	124262	159884	174443	160343	187074	134584	80773	81885	81913	164821	81885
Medium	40715	40392	46250	44630	36004	41904	18945	30679	44838	62688	126319	13636	13636	61092	13636
Low	49836	45649	35411	10113	21467	10828	19887	29957	11930	45399	7845	7845	7845	7845	7845
Not Eval	2830	2781	4567	1394	9189	3212	552	6296	567	567	567	567	567	567	567
Total	245580	208651	212779	212828	190922	215828	213827	227275	244409	243238	215504	103933	103961	234325	103933
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	159837	107942	151645	159704	123978	149302	160392	170416	177721	141166	180530	68959	68987	199351	68959
USACE	158	3120	354	354	354	354	354	354	354	354	354	354	354	354	354
FORC	20994	11755	12168	14880	25837	22053	17758	12535	43063	44978	15434	15434	15434	15434	15434
MDW	983	533	533	533	533	533	533	533	533	533	533	533	533	533	533
MEDCOM	5411	23782	771	771	771	771	771	771	771	771	771	771	771	771	771
NGB	7128	3505	3530	908	13784	16260	12831	2410	2410	2410	2410	2410	2410	2410	2410
TRADOC	22779	34984	29055	15966	12425	11070	5295	5295	5295	5295	5295	5295	5295	5295	5295
USAPC	9149	6382	5184	12067	7095	3715	9516	21124	7869	41338	3784	3784	3784	3784	3784
USARC	18438	16355	9246	7352	5852	11477	6084	13544	6100	6100	6100	6100	6100	6100	6100
USMA	703	293	293	293	293	293	293	293	293	293	293	293	293	293	293
Total	245580	208651	212779	212828	190922	215828	213827	227275	244409	243238	215504	103933	103961	234325	103933
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Number of Projects by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	868	348	216	155	74	47	38	24	17	13	5	2	0	2	0
Medium	333	166	89	46	20	16	4	6	4	4	3	2	0	1	0
Low	372	186	112	29	7	3	6	7	2	2	1	0	0	0	0
Not Eval	41	17	7	4	3	3	1	1	1	0	0	0	0	0	0
Total	1614	717	424	234	104	69	49	38	24	19	9	4	0	3	0

Number of Projects by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	970	456	269	164	80	49	37	29	16	13	6	4	0	3	0
USACE	6	1	2	0	0	0	0	0	0	0	0	0	0	0	0
FORC	152	50	16	12	9	8	1	0	4	4	2	0	0	0	0
MDW	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0
NGB	33	22	7	3	5	4	6	3	0	0	0	0	0	0	0
TRADOC	201	112	65	43	6	5	1	0	0	0	0	0	0	0	0
USAPC	87	14	11	7	4	1	2	5	3	2	1	0	0	0	0
USARC	126	56	52	5	0	2	2	1	1	0	0	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1614	717	424	234	104	69	49	38	24	19	9	4	0	3	0

Number of Intallations with Remedy in Place for All Projects															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	6	5	3	3	2	2	4	3	5	1	1	1	2	0
USACE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FORC	2	0	2	3	1	2	0	0	1	2	1	0	0	0	0
MDW	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
NGB	2	1	2	0	0	0	1	2	0	0	0	0	0	0	0
TDOC	2	1	3	4	2	2	1	0	0	0	0	0	0	0	0
USAPC	2	1	2	3	2	0	0	0	0	0	1	0	0	0	0
USARC	27	5	18	3	0	0	2	0	1	0	0	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	49	17	34	16	8	6	6	6	5	7	3	1	1	2	0

For the budget in which the FY 2005 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	155819	134331	131981	152641	146998	151740	162469	125184	122414	177299	134183	128476	81885	81885	81885
Medium	40204	31585	48237	32530	25175	28826	19295	37326	89986	20502	41090	126319	61092	13636	13636
Low	47582	39391	27657	18012	15918	10685	11725	36962	13453	22361	44783	7845	7845	7845	7845
Not Eval	2830	3344	4904	9645	2768	552	552	6296	567	567	567	567	567	567	567
Total	246435	208651	212779	212828	190859	191803	194041	205768	226420	220729	220623	263207	151389	103933	103933
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	154215	112039	141524	171137	132717	130810	123762	154197	181237	137208	151211	225819	116415	68959	68959
USACE	158	3120	354	354	354	354	354	354	354	354	354	354	354	354	354
FORC	21142	12004	13917	9780	26566	23214	43863	14539	12894	44978	15434	15434	15434	15434	15434
MDW	983	533	533	533	533	533	533	533	533	533	533	533	533	533	533
MEDCOM	5411	23782	771	771	771	771	771	771	771	771	771	771	771	771	771
NGB	14078	2700	6191	2346	9900	9342	2107	2107	2107	11007	4920	2410	2410	2410	2410
TRADOC	25746	24444	31068	10035	4568	16576	8910	12072	5295	5295	5295	7709	5295	5295	5295
USAPC	9149	8131	10282	7227	6523	3312	7364	14818	9392	14190	35712	3784	3784	3784	3784
USARC	14850	21605	7846	10352	8634	6598	6084	6084	13544	6100	6100	6100	6100	6100	6100
USMA	703	293	293	293	293	293	293	293	293	293	293	293	293	293	293
Total	246435	208651	212779	212828	190859	191803	194041	205768	226420	220729	220623	263207	151389	103933	103933
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	857	357	228	149	62	41	41	22	11	17	16	5	3	0	0
Medium	331	161	91	43	13	12	5	8	7	5	9	6	3	0	0
Low	371	188	110	27	7	4	3	6	3	4	4	0	0	0	0
Not Eval	41	17	8	6	4	0	0	1	1	0	0	0	0	0	0
Total	1600	723	437	225	86	57	49	37	22	26	29	11	6	0	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	957	458	279	161	66	37	34	31	17	18	22	10	6	0	0
USACE	6	1	2	0	0	0	0	0	0	0	0	0	0	0	0
FORC	152	51	17	8	7	10	6	1	1	3	2	0	0	0	0
MDW	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0
NGB	34	21	9	5	3	3	4	0	0	1	3	0	0	0	0
TRADOC	202	109	64	41	5	5	4	1	1	0	0	1	0	0	0
USAPC	87	15	15	5	3	0	1	4	2	3	2	0	0	0	0
USARC	123	62	49	5	2	2	0	0	1	1	0	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1600	723	437	225	86	57	49	37	22	26	29	11	6	0	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	5	5	5	0	1	4	2	2	2	3	5	4	0	0
USACE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FORC	2	1	2	2	0	2	2	0	1	1	1	0	0	0	0
MDW	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
NGB	2	1	2	1	0	0	0	0	0	0	2	0	0	0	0
TDOC	3	1	3	4	0	0	2	0	1	0	0	1	0	0	0
USAPC	2	1	3	1	2	0	0	1	0	0	1	0	0	0	0
USARC	27	5	18	2	1	2	0	0	0	1	0	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	50	17	35	15	3	5	8	3	4	4	7	6	4	0	0

C.4 ALTERNATIVE D. Prioritization based on MACOM with LTM/LTO costs incurred for 5 years.

For the budget in which the FY 2004 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	149934	124779	150899	138191	126545	170093	147979	178573	140086	77684	21001	9078	7516	2120	1563
Medium	39859	43144	31880	39710	34718	34878	52367	22590	65221	164664	7498	1276	1222	1194	758
Low	54345	37047	26774	29056	21453	10570	15325	20074	32886	941	132	4209	48	30	30
Not Eval	1982	3681	3226	5871	5422	136	112	5856	82	3303	21	21	21	6	6
Total	246120	208651	212779	212828	188138	215677	215783	227093	238275	246592	28652	14584	8807	3350	2357
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	161064	107337	145291	147988	119526	167227	174003	176485	165630	236713	22604	9838	4425	2893	2357
USACE	158	3120	354	354	354	256	256	0	0	0	0	0	0	0	0
FORC	19002	13561	13925	13936	26796	10860	9314	34784	37516	7590	5278	4364	4364	457	0
MDW	983	533	533	533	533	50	0	0	0	0	0	0	0	0	0
MEDCOM	5411	23782	771	771	771	602	591	0	0	0	0	0	0	0	0
NGB	6280	2700	4152	2314	12378	18272	10726	1554	1502	1502	700	345	0	0	0
TRADOC	25056	24049	31557	13027	14342	11395	7985	2183	986	736	19	19	0	0	0
USAPC	12633	12371	6657	13175	7045	3048	10981	11666	32393	51	51	18	18	0	0
USARC	14830	20905	9246	20437	6100	3937	1927	421	248	0	0	0	0	0	0
USMA	703	293	293	293	293	30	0	0	0	0	0	0	0	0	0
Total	246120	208651	212779	212828	188138	215677	215783	227093	238275	246592	28652	14584	8807	3350	2357
Budget	246435	208651	212779	212828	191041	215828	215828	228028	249028	249028	250028	301028	301028	301028	301028

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	868	358	209	146	69	50	46	32	17	10	3	0	1	0	0
Medium	330	169	83	44	22	14	14	5	4	5	3	1	0	0	0
Low	372	184	105	35	9	7	4	5	3	1	1	1	0	0	0
Not Eval	40	18	7	4	4	1	0	1	1	1	1	0	0	0	0
Total	1610	729	404	229	104	72	64	43	25	17	8	2	1	0	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	969	458	254	159	74	53	50	35	18	15	8	2	1	0	0
USACE	6	1	2	0	0	0	0	0	0	0	0	0	0	0	0
FORC	150	52	17	9	11	7	3	2	5	2	0	0	0	0	0
MDW	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0
NGB	32	21	8	4	4	5	6	3	0	0	0	0	0	0	0
TRADOC	203	111	59	41	9	6	3	1	0	0	0	0	0	0	0
USAPC	88	17	14	8	3	1	2	2	2	0	0	0	0	0	0
USARC	123	63	48	8	3	0	0	0	0	0	0	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1610	729	404	229	104	72	64	43	25	17	8	2	1	0	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	5	3	7	3	2	2	6	2	2	3	2	1	0	0
USACE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FORC	3	0	2	1	1	3	1	0	2	1	0	0	0	0	0
MDW	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
NGB	2	1	2	0	0	0	1	2	0	0	0	0	0	0	0
TDOC	3	1	3	3	1	1	2	1	0	0	0	0	0	0	0
USAPC	2	1	2	2	2	1	0	0	1	0	0	0	0	0	0
USARC	27	5	18	3	3	0	0	0	0	0	0	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	51	16	32	16	10	7	6	9	5	3	3	2	1	0	0

For the budget in which the FY 2005 figure is projected for FY 2006-FY 2014.

Cost by Risk Factor (FY 99 $K)															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	150750	136533	135503	148692	117759	155881	154084	128216	153169	77409	64397	14891	5433	3215	109
Medium	42960	32724	36553	40564	41092	21915	30483	53474	53894	116821	48783	1314	18172	1234	810
Low	47223	36280	32941	22126	23097	11249	9143	23552	14911	32121	88	69	69	51	0
Not Eval	5502	2793	7782	1446	8506	3427	121	121	21	21	6	0	0	0	0
Total	246435	208330	212779	212828	190454	192472	193831	205363	221995	226372	113274	16274	23674	4500	919
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Cost by Major Command (FY 99 $K)															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	161236	112223	143548	156442	128200	141659	161377	168109	141646	186206	108656	12702	18635	1869	861
USACE	158	3120	354	354	354	256	256	0	0	0	0	0	0	0	0
FORC	20221	10704	15570	12961	21162	22236	11979	5614	63822	5796	3758	2844	2540	2540	0
MDW	983	533	533	533	533	50	0	0	0	0	0	0	0	0	0
MEDCOM	5411	23782	771	771	771	602	591	0	0	0	0	0	0	0	0
NGB	7128	2700	5386	3745	10410	9023	9303	10151	1470	1470	668	668	303	0	0
TRADOC	29492	24967	23756	17637	15278	9009	4228	1750	4494	724	19	0	0	0	0
USAPC	6849	9415	5901	11224	4803	5670	1828	19233	10331	32101	173	60	2196	91	58
USARC	14254	20593	16667	8868	8650	3937	4269	506	232	75	0	0	0	0	0
USMA	703	293	293	293	293	30	0	0	0	0	0	0	0	0	0
Total	246435	208330	212779	212828	190454	192472	193831	205363	221995	226372	113274	16274	23674	4500	919
Budget	246435	208651	212779	212828	191041	194041	194041	206241	227241	227241	228241	279241	279241	279241	279241

Number of Site/Phases by Risk Factor															
	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
High	857	352	222	155	61	48	42	38	19	11	4	0	0	0	0
Medium	333	167	85	41	20	13	10	10	5	3	3	0	2	2	0
Low	372	184	109	31	10	6	4	3	5	3	0	0	0	0	0
Not Eval	42	18	8	5	2	2	1	0	0	0	0	0	0	0	0
Total	1604	721	424	232	93	69	57	51	29	17	7	0	2	2	0

Number of Site/Phases by Major Command															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	963	455	270	163	69	50	45	41	20	11	7	0	1	1	0
USACE	6	1	2	0	0	0	0	0	0	0	0	0	0	0	0
FORC	150	51	17	11	9	8	4	2	2	4	0	0	0	0	0
MDW	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0
NGB	33	21	8	6	3	3	2	5	2	0	0	0	0	0	0
TRADOC	205	112	60	39	8	6	2	0	1	0	0	0	0	0	0
USAPC	86	14	14	6	2	1	3	3	4	2	0	0	1	1	0
USARC	122	61	51	7	2	1	1	0	0	0	0	0	0	0	0
USMA	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1604	721	424	232	93	69	57	51	29	17	7	0	2	2	0

Number of Installations with Remedy in Place for All Site/Phases															
MACOM	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
AMC	7	5	3	4	5	3	3	2	4	3	5	0	0	1	0
USACE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FORC	3	0	2	1	1	2	2	1	0	2	0	0	0	0	0
MDW	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDCOM	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
NGB	2	1	2	1	0	0	0	1	1	0	0	0	0	0	0
TDOC	3	1	3	3	2	0	2	0	1	0	0	0	0	0	0
USAPC	2	1	3	2	1	0	0	0	0	1	0	0	0	1	0
USARC	27	5	18	3	1	1	1	0	0	0	0	0	0	0	0
USMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	51	16	33	14	10	6	8	4	6	6	5	0	0	2	0

GLOSSARY

ACSIM	Assistant Chief of Staff for Installation Management
AMC	Army Materiel Command
AEC	Army Environmental Center
BRAC	base realignment and closure
CAA	Center for Army Analysis
DEP	Director of Environmental Programs
FORSCOM	Forces Command
FUDS	formerly used defense sites
FY	fiscal year
LTM	long-term monitoring
LTO	long-term operations
MACOM	major Army command
MDW	Military District of Washington
MEDCOM	Medical Command
NGB	National Guard Bureau
ODE	Office of the Director of Environmental Programs
POM	Program Objective Memorandum
TRADOC	Training and Doctrine Command
USACE	US Army Corps of Engineers
USAPC	US Pacific Command
USARC	US Army Reserve Component
USMA	US Military Academy